PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in Aircraft

We, BLACKBURN AND GENERAL AIRCRAFT LIMITED, a British Company, of Brough, East Yorkshire, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to aircraft and particularly to high speed aircraft intended to fly at very high speeds in the sonic range.

From comparatively early times proposals have been made to provide an aircraft in which the wing may swing back from a position substantially normal to the longitudinal axis of the fuselage to a position in which they are sharply rearwardly inclined with a view to reducing frontal resistance during flight in what was then the higher speed ranges, although in such proposals it was not suggested that the aircraft could approach sonic speeds, and it is now-a-days thought that for flight at certain high speeds a sharply swept-back wing is desirable.

The movement of the wings from their spread to swung-back position brings about a fore and aft movement of the centre of gravity with a similar movement of the centre of pressure and a particular object of the present invention is to provide a high speed aircraft having a hinged wing arrangement which will enable speeds to be obtained well into the sonic range without involving unduly high landing speeds and the loss in stability and control associated with swept back wing aircraft at take off and landing, and in which the change in the position of the centre of gravity consequent on movement of the wings is increased in order to offset the effect of the change in position of the centre of pressure.

To this end, the present invention comprises a hinged wing aircraft having a fuselage and empennage wherein the fuselage is provided with lateral extensions disposed symmetrically on each side within which are hinged the roots of wings capable of being swung from a spread position extending substantially normal to the longitudinal axis of the fuselage to a swept-back position in which, with the extension, they give a wing plan of substantially delta form, and wherein tanks are provided in the leading edges of the wings to accommodate an amount of fuel arranged to be used last of all such that the mass of such fuel in the wing tanks, due to change in position relative to the longitudinal axis of the aircraft on displacing the wings, accentuates the change in the position of the centre of gravity which then occurs and thereby tends to offset the effect of the change of position of the centre of pressure.

The aircraft empennage is separate from the wings in both spread and swung-back positions and preferably comprises all moving tail surfaces capable of being moved symmetrically for control in the pitching plane and asymetrically for control in yaw.

The swinging movement of the wings is effected by hydraulic jacks co-operating with locks for latching the wings in both spread and sweptback positions and means are provided for ensuring synchronous movement of the wings in both directions.

The movement is particularly applicable to an aircraft design in which a turbo-jet engine is contained within the fuselage with the efflux duct extending out through the rear thereof with the empennage situated thereabove when the fuel tanks in the fuselage are formed as saddles or annuli.

Now in order that the invention may be clearly understood and readily carried into effect, an embodiment thereof is, by way of example, hereinafter more fully described with reference to the accompanying drawings which are given for purposes of illustration only and not of limitation.

In these drawings:—

Figure 1 shows the aircraft plan form

[ ]

with the wings spread and includes the illustration of essential features;

Figure 2 is a view similar to Figure 1 with the wings swung back to their swept-back position;

Figure 3 is a transverse section on the line III—III of Figure 2 to show the substantially annular shape of the forward fuselage fuel tank;

Figure 4 is a transverse section on the line IV—IV of Figure 2 to show the substantially annular shape of the rear fuselage fuel tank, and

Figure 5 is a detail view on an enlarged scale showing spread wing locking means, the jack for effecting swinging movement of the wing and the means for ensuring synchronous movements of the jacks.

Referring now to the said drawings, and in particular to Figures 1 and 2 thereof, the aircraft here illustrated has an elongated fuselage 1 with a sharply pointed nose 2 and has symmetrically at each side a lateral extension 3 within each of which is pivoted at 4 a wing 5 which is mounted to be capable of swinging movement about such hinge 4 from a spread position extending substantially normal to the longitudinal axis of the aircraft as illustrated in Figure 1, in which position the span and aspect ratio are at their maximum, to a swept-back position in which the wings 5 are at an acute angle in which position they with the extensions 3 into which parts of the wings are retracted make up a wing plan of substantially delta form. It will be appreciated that the action of sweeping the wing forward from the high speed to the low speed configuration results in increase in the thickness/chord ratio of the aerofoil section in the line of flight, increase in the leading edge radius and the point at which maximum thickness/chord ratio occurs moving forward on the section. Each of these features is of benefit in low speed flight and the increased aspect ratio in this spread position gives increased stability and lateral control which is very necessary at take-off and landing.

Landing of the aircraft is further facilitated by providing trailing edge split flaps 37 on the wings and similar flaps 38 on the under surfaces of the lateral extensions 3 of the fuselage 1 which may also be provided with dive brakes comprising oppositely swinging hinged members 39 on the upper and lower surfaces respectively of the extensions 3 which may be swung out to project into the air stream when required.

The rear end of the fuselage 1 carries an all-moving surface empennage 6 comprising a short fin supporting all-moving tailplane surfaces having a substantial dihedral angle. A turbo-jet engine 7 is provided within the fuselage in the region of the centre of gravity and the efflux pipe from such engine extends out through the rear extremity of the fuselage. Combustion air is taken in at intakes 8, 9 at the front of the fuselage and carried by ducts to the front of the engine 7.

A substantially annular fuel tank 10 is provided towards the front of the aircraft with the hollow core of such tank forming the air supply duct leading to the front of the engine 7 (see Figure 3). A similar tank 11 is conveniently provided towards the rear of the fuselage (see also Figure 4) when the efflux duct 12 from the motor 7 conveniently passes through the hollow core thereof. A fuel tank 13 is also provided in the leading edge of each wing, and the fuel from these tanks is taken by conduits 15 and 15^1 to a delivery tank 14 which feeds the fuel to the engine. The fuel tank 10 is connected to the fuel tank 13 in the one wing by a flexible conduit 17 and the fuel tank 11 is similarly connected by an at least partly flexible conduit 16 to the fuel tank in the other wing. A cylinder 40 of an inert gas under pressure is connected to the tank 10 by a pipe 41 and to the tank 11 by a pipe 42. The pressure of this gas forces the fuel from the tanks 10, 11 to the wing fuel tanks 13 so that the latter are always full and after the tanks 10, 11 have been emptied the gas feeds into the wing tanks 13 to continue to force the fuel therefrom to the delivery tank 14. The fuel in the wing tank is therefore used last of all and the mass of the fuel in such wing tanks 13 due to their displacement relative to the aircraft datum line on displacement of the wings between spread and swept-back positions accentuates or causes a greater fore and aft displacement of the centre of gravity of the aircraft which then occurs and such greater displacement of the centre of gravity tends to reduce the effect of the fore and aft displacement of the centre of pressure due to such change of wing position.

Each wing 5 is moved between its spread position as in Figure 1 to its swept-back position as in Figure 2 by means of a hydraulic jack 36, the extension of the ram 36^1 of which effects the hinging movement of the wing 5 about its hinge (see also Figure 5). The supply of operating fluid to the jacks 36 for moving the respective wings 5 is regulated to ensure the synchronous or substantially equal rate of operation so that the two wings will move together. This may be accom-

plished, for example, by feeding the operating fluid from a controlling valve (not shown) through a conduit 50 to a regulating valve situated on the datum line of the fuselage, the body 51 of which valve is movable and contains pistons 52, 53, on a common piston rod 54, arranged to vary the openings to conduits 55, 56 connected to the respective jacks 36. The valve body 51 is connected by a link 57 to a bell crank lever 58 which is in turn connected by a link 59 to a bell crank lever 60 the other limb of which is connected by a link 61 to the wing 5. The piston rod 54 is connected by a link 62 to a bell crank lever 63 which is similarly connected by links and bell crank lever to the other wing. So long as the wings 5 move together at substantially the same rate their movements taken through the links and levers move both the valve body 51 and piston rod 54. If, however, the rate of movement becomes uneven some relative movement occurs between the valve body 51 and the piston rod 54 so that the pistons 52, 53 alter the size of the openings to the conduits 55, 56 with the result that the supply of fluid to the more rapidly moving jack is throttled whilst more fluid is supplied to the other jack to increase its rate of operation, until the lagging wing catches up whereupon the valve body 51 and piston rod 54 are restored to normal relative position.

The wing 5 is locked in its spread position (see Figure 5) by a portion 65 thereof abutting a part 66 of the fuselage such that a projection 67 on the abutment 66 may enter a bore 68 in the wing portion 65. A jack 69 has a piston rod 70 capable of entering another bore in the wing portion 65 effectively to lock the wing in spread position as shown in broken lines in Figure 5. A similar hydraulic jack 71 (see Figure 1 or 2) has its piston 72 capable of engaging in a bore 73 in the trailing edge of the wing when the same is in swept-back position in order effectively to lock the wing in that position. Other locking means may additionally or alternatively be provided.

In addition to the advantage of enabling a high speed aircraft to be taken off and landed at a comparatively low speed with adequate stability, the folding wing arrangement has the additional advantage of enabling initial flight trials to be carried out with the wings in the spread low speed position until the pilot is completely familiar with the aircraft in its conventional form.

What we claim is:—

1. A hinged wing high speed aircraft having a fuselage and empennage wherein the fuselage is provided with lateral extensions disposed symmetrically on each side within which are hinged the roots of wings capable of being swung from a spread position extending substantially normal to the longitudinal axis of the fuselage to a swept-back position in which, with the extensions, they give a wing plan of substantially delta form, and wherein tanks are provided in the leading edges of the wings to accommodate an amount of fuel arranged to be used last of all such that the mass of such fuel in the wing tanks, due to change in position relative to the longitudinal axis of the aircraft on displacing the wings, accentuates the change in the position of the centre of gravity which then occurs and thereby tends to offset the effect of the change of position of the centre of pressure.

2. A hinged wing high speed aircraft as claimed in Claim 1, wherein fuel tanks provided in the fuselage are emptied by inert gas under pressure into the wing tanks from which the fuel is fed to the engine.

3. A hinged wing high speed aircraft as claimed in either of the preceding claims, wherein equal or substantially equal rates of movement of the wings between spread and swept-back positions are ensured by a regulating valve, the body and piston rod of which are connected by linkages to the respective wings, controlling the supply of operating fluid to hydraulic jacks which effect movement of the wings.

4. A hinged wing high speed aircraft as claimed in any of the preceding claims, wherein the wings are locked in both spread and swept-back positions by means of hydraulic jacks the pistons of which engage in recesses in the wings.

5. A hinged wing high speed aircraft substantially as hereinbefore described with reference to the accompanying drawings.

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PROVISIONAL SPECIFICATION

Improvements in Aircraft

We, BLACKBURN AND GENERAL AIRCRAFT LIMITED, a British Company, of Brough, East Yorkshire, do hereby declare the nature of this invention to be as follows:—

This invention relates to aircraft and

particularly to high speed aircraft intended to operate at supersonic speeds, the chief object being to evolve a wing arrangement which will enable speeds to be obtained well into the sonic range without involving dangerously high take-off and landing speeds. With this object in view it is proposed to employ a high degree of sweepback for high flight and to change the plan form of the wings to give reasonable handling qualities at reasonably low speeds as, for example, for take-off, landing or when climbing.

An aircraft according to the present invention includes a fuselage carrying wings and a tailplane, the wings being capable of hinging movement from a spread position in which their longitudinal axes lie normal or substantially normal to the longitudinal axis of the fuselage in which position the open and aspect ratio are at their maximum to a position in which the wings are swept back at an acute angle to give a wing plan of substantially delta form.

An aircraft according to a further aspect of the present invention includes wings which are capable of forward hinging movement from a high speed position in which the leading edges of the wings are swept back at an acute angle with respect to the longitudinal axis of the fuselage to a spread low speed position in which the span and aspect ratio are materially increased and wherein the wings whilst maintaining their general cross-sectional profile have sections in line of flight of which the geometrical proportions are better adapted to the reduced speed flight conditions. It will be appreciated that the action of sweeping the wing forward from the high speed to the low speed configuration causes the wing chord to be reduced in proportion to the cosine of the angle of sweep. The general effect is to increase the thickness/chord ratio of the aerofoil section in line of flight, to increase the leading edge radius and to cause the point at which maximum thickness/chord ratio occurs to move forward on the section. Each of these features is of benefit in low speed flight.

Furthermore the inclination of the hinge about which the wing swings can be so chosen as to give an increased dihedral angle of the wing as it sweeps forward and thereby provide a greater degree of lateral stability to the aircraft in this configuration.

According to a further aspect of the present invention an aircraft intended normally for operation at high speeds and fitted with swept back wings is characterised in that the wings are capable of angular movement in a forward direction into a position in which their effective wing area, span and aspect ratio are increased for take-off and landing.

According to a further feature of the invention the wings are mounted for forward hinging movement about hinge axes situated within skirts or cuffs which project from the fuselage on opposite sides. These skirts or cuffs also serve to accommodate wing locking devices for locking the wings in their folded or spread positions.

It will be appreciated that movement of the wings from their folded to spread position will bring about movement of the centre of pressure and in order that the correct relationship between the centre of pressure and centre of gravity shall be maintained when the wings are in their folded and spread positions it is proposed according to a further feature of the invention to arrange some of the fuel tanks in the leading edges of the wings which fuel is kept in reserve as ballast and is only used during descent and when landing when the wings have been moved into their spread position, the fuel in the wing tanks forming a mass of a sufficient magnitude to bring about automatically the desired forward movement of the centre of gravity to maintain correct relationship with the centre of pressure during its forward movement consequent upon hinging movement of the wings in a forward direction.

Although it is preferred that there shall be a substantial increase in span resulting from forward movement of the wings into their spread position it is not necessarily proposed to increase the wing area proportionally, the skirts or cuffs on the aircraft fuselage being so positioned and dimensioned that the action of moving the wings from their folded to their spread positions will expose a part of the wing adjacent the trailing edge which was previously enclosed by the skirt when the wings were folded and will cause a part of the wing near the leading edge to be enclosed, the skirts forming fixed root fairings which merge into the upper and lower surfaces of the wings when the wings are in a high speed folded position but at the same time permit of forward hinging movement into their low speed position.

In a preferred arrangement the aircraft includes a fuselage, housing a turbo jet power unit and tankage for the main fuel supply, the tanks being of substantially annular or saddle formation and encompassing or partially encompassing the jet unit. The fuselage carries on its opposite sides comparatively large skirts or cuffs arranged on or substantially on the thrust

line which skirts enclose a substantial part of the wings when the latter are in their folded position in which position they are swept back approximately 60° at the leading edge. The degree of sweep-back can of course be varied to suit the thrust of the power unit available or to suit other circumstances.

The wings are of the single spar type and are hinged at the root to a robust hoop frame in the fuselage, the hinge points being located within the skirts as also are the wing locking points for locking the wings in their folded and spread positions and the wing actuating mechanism which may take the form of an hydraulic jack of suitable capacity.

The fuselage at the rear carries a short fin supporting all-moving tailplane surfaces having a substantial dihedral angle, it being proposed that the tailplane surfaces shall be moved symmetrically for control in the pitching plane and asymmetrically for control in yaw.

Flaps of suitable design to increase the effective lift coefficient are provided on the wings for use during landing the flaps being enclosed within the skirts when the wings are in the high speed position, the skirts being fitted with air brakes.

In addition to the advantage of enabling a high speed aircraft to be taken off and landed at comparatively low speed, the folding wing arrangement has the additional advantage of enabling initial flight trials to be carried out with the wings in the spread low speed position until the pilot is completely familiar with the aircraft in its convential form.

Dated this 28th day of April, 1943.

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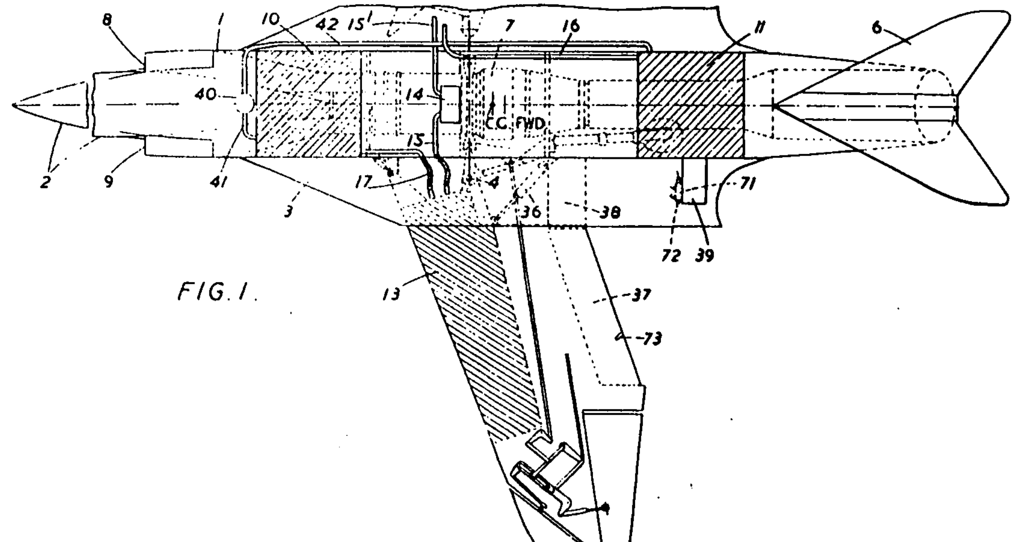
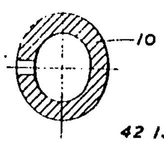


FIG. 1.

FIG. 3.



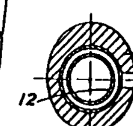


FIG. 4.

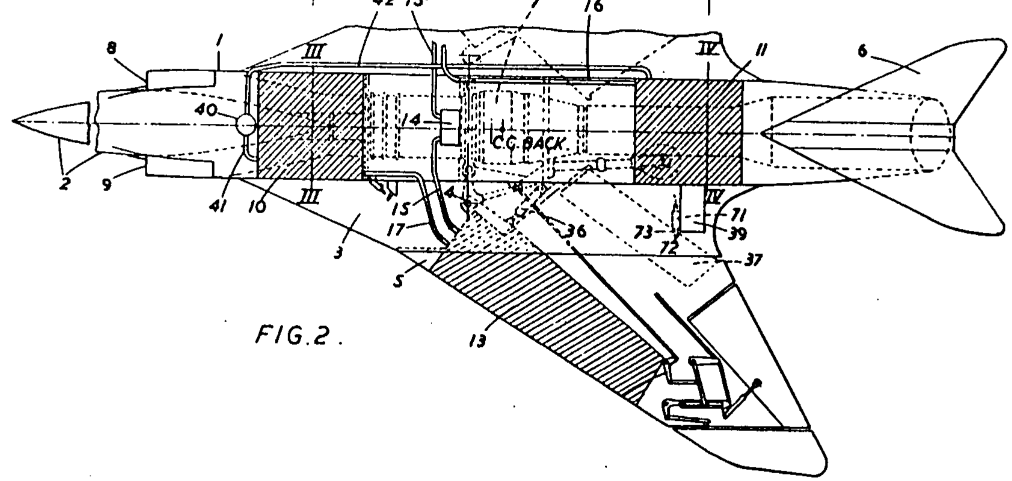


FIG. 2.

This Drawing is a reproduction of the Original on a reduced scale

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FIG. 5.